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Zilka-Kotab, PC
P.O. BOX 721120
SAN JOSE, CA 95172-1120

EXAMINER

GUILL, RUSSELL L

ART UNIT	PAPER NUMBER
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2123

DATE MAILED: 10/18/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/099,721

Applicant(s)

JAMES, GREGORY E.

Examiner

Russ Guill

Art Unit

2123

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 September 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-31 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-31 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 14 March 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. This non-final Office Action is in response to an Amendment filed September 13, 2006. No were added. Claims 32 - 33 were canceled. Claims 1 - 31 are pending. 1 - 31 have been examined. Claims 1 - 31 have been rejected. Claim 11 is allowable over the prior art of record.
2. Following review with senior examination staff, this Office Action is NON-final due to new rejections under 35 U.S.C. § 101 and new art.
3. The indicated allowability of claim 10 is withdrawn in view of the newly cited reference(s) of Rumpf (Martin Rumpf et al.; "Using Graphics Cards for Quantized FEM Computations", September 3 - 5 2001, Proceedings of the IASTED International Conference on Visualization, Imaging and Image Processing). Rejections based on the newly cited reference(s) follow.
4. As recited in the previous Office Action, the Examiner would like to thank the Applicant for the well-presented response, which was useful in the examination process. The Examiner appreciates the effort made to perform a careful analysis and present clear arguments.

Response to Remarks

5. Regarding claims 1 - 33 rejected under 35 USC § 112, first paragraph:
 - a. Applicant's arguments overcome the rejection.
6. Regarding claims 1 - 33 rejected under 35 USC § 112, second paragraph:
 - a. Applicant's amendments to the claims overcome the rejection.
7. Regarding claim 1 rejected under 35 USC § 101:
 - a. Applicant's arguments have been fully considered, but are not persuasive, as follows.
 - b. The Applicant argues:

- i. Specifically, applicant asserts that “the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes,” in the manner claimed, thus clearly producing a tangible result.
 - c. The Examiner respectfully replies:
 - i. The Examiner respectfully disagrees. The act of determining a location of surfaces or objects for rendering purposes does not appear to produce a tangible result. Accordingly, the rejection is maintained.
 - d. The Applicant argues:
 - i. In addition, with respect to claims 10 and 11, applicant respectfully asserts that the techniques “wherein the local area of textures is filtered utilizing a filter including a plurality of elements (see Claim 10 – emphasis added) and “wherein the local area of textures is used to sample a texture map to generate a modified local area of textures” (see Claim 11 – emphasis added) both produce a tangible result.
 - e. The Examiner respectfully replies:
 - i. The Examiner respectfully disagrees, and notes that the aforementioned limitations do not appear to produce a tangible result. Generating and filtering operations do not appear to produce tangible results.
 - f. The Applicant argues:
 - i. It should also be noted that the various method claims have each been amended to require a “hardware graphics pipeline-implemented method” (emphasis added).
 - g. The Examiner respectfully replies:
 - i. Computer hardware implemented methods are no longer sufficient to ensure a tangible result.
8. Regarding claims 1 - 2, 12 - 18, 22- 23, and 27 rejected under 35 USC § 103:
- a. Applicant's arguments have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 101

9. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

10. Claims 1 - 25 and 28 - 31 are rejected under 35 U.S.C. § 101 because the claimed invention is directed to non-statutory subject matter.

a. Regarding claims 1 - 25 and 28 - 31, the claims do not appear to produce a tangible result to form the basis of a practical application needed to be statutory. Generating or computing a solution does not appear to produce a tangible result. Further, enhancing graphics processing operations does not appear to produce a tangible result. Further, rendering does not appear to necessarily produce a tangible result. If the Applicant believes that an interview would be useful to resolve this rejection, then the Applicant is invited to call the Examiner.

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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12. Regarding all claims 1 - 31, the art of Rumpf teaches using a graphics hardware pipeline to solve partial differential equations. After the inventive step of Rumpf, implementing any known method of solving a partial differential equation using a hardware graphics pipeline would have been obvious.

13. Claims 1 - 2, 12 - 18, 22 - 23 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Press (Press, William H.; Flannery, Brian P.; Teukolsky, Saul A.; Vetterling, William T.; "Numerical Recipes in Fortran 77", 2001, Second edition, Cambridge University Press) in view of Rumpf (Martin Rumpf et al.; "Using Graphics Cards for Quantized FEM Computations", September 3 - 5 2001, Proceedings of the IASTED International Conference on Visualization, Imaging and Image Processing).

a. Regarding claim 1:

b. Press appears to teach:

- i. Receiving input (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that input is required to solve a partial differential equation, especially given the statement that an initial distribution relaxes to an equilibrium distribution on page 855);
- ii. Processing the input to generate the solution to the partial differential equation (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems);

c. Press does not specifically teach:

- i. Receiving input in the hardware graphics pipeline;
- ii. Processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline;
- iii. Wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline.
- iv. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline.

d. Rumpf appears to teach:

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- i. Receiving input in the hardware graphics pipeline (*third page, figure 1*);
 - ii. Processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline (*third page, section 3.1 Vector Representation, first paragraph; and seventh page, section 6. Linear Heat Equation, first paragraph*);
 - iii. Wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline (*seventh page, section 6. Linear Heat Equation, first paragraph*);
 - iv. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline (*ninth page, figure 3, displays surfaces and objects rendered by utilizing the solution to a partial differential equation utilizing a hardware graphics pipeline*).
- e. The motivation to use the art of Rumpf with the art of Press would have been the benefits recited in Rumpf that the presented strategy opens a wide area of numerical applications for hardware acceleration (*first page, Abstract, first paragraph*), and turns a graphics card into an ultrafast vector coprocessor (*first page, Abstract, first paragraph*), which would have been recognized by the ordinary artisan as benefits that allow faster processing.
- f. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Rumpf with the art of Press to produce the claimed invention.

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- g. Regarding claim 2:
- h. Press appears to teach:
- i. Input represents boundary conditions (*pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that boundary conditions are required to solve a partial differential equation, especially since the title of the section recites Boundary Value problems*);

=====

- i. Regarding claim 12:
- j. Press appears to teach:
 - i. The processing includes a relaxation operation (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that processing includes a relaxation operation, especially since the title of the section recites Relaxation Methods);

=====

- k. Regarding claim 13:
- l. Press appears to teach:
 - i. The relaxation operation is selected based on the partial differential equation (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that the relaxation operation is selected based on the partial differential equation, especially since such an example is presented);

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- m. Regarding claim 14:
- n. Press appears to teach:
 - i. The processing includes a plurality of iterations of the relaxation operation (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems; especially references to Gauss-Seidel method and Jacobi's method);

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- o. Regarding claim 15:
- p. Press appears to teach:
 - i. A number of iterations of the relaxation operation is reduced using at least one of a prolongation operation and a restriction operation (pages 862-868, section 19.6);

Multigrid Methods for Boundary Value Problems, especially page 865 Smoothing, Restriction and Prolongation Operators);

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q. Regarding claim 16:

r. Press appears to teach:

i. The processing further includes determining whether the solution has converged (pages 855, Relaxation Methods for Boundary Value Problems; second paragraph, section that starts with "Thus the algorithm consists . . .", sentence, "This procedure is then iterated until convergence.");

=====

s. Regarding claim 17:

t. Press appears to teach:

i. It is determined whether the solution has converged after each iteration of the relaxation operation (pages 855, Relaxation Methods for Boundary Value Problems; second paragraph, section that starts with "Thus the algorithm consists . . .", sentence, "This procedure is then iterated until convergence.");

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u. Regarding claim 18:

v. Press appears to teach:

i. It is determined whether the solution has converged after a predetermined number of multiple iterations of the relaxation operation (pages 855, Relaxation Methods for Boundary Value Problems; second paragraph, section that starts with "Thus the algorithm consists . . .", sentence, "This procedure is then iterated until convergence.");

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w. Regarding claim 22:

x. Press appears to teach:

- i. If it is determined that the solution has converged repeating the processing using an altered parameter value operation (pages 862-868, section 19.6 Multigrid Methods for Boundary Value Problems; it would have been obvious to altering a grid size is altering a parameter);

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y. Regarding claim 23:

z. Press appears to teach:

- i. The number of iterations of the relaxation operation is determined prior to the processing (pages 860, Relaxation Methods for Boundary Value Problems; code example with a parameter value MAXITS = 1000 and a loop DO N=1,MAXITS);

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aa. Regarding claim 27:

- i. Claim 27 is taught as in claim 1 above.

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14. Claims 19 - 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Press as modified by Rumpf as applied to claims 1 - 2, 12 - 18, 22 - 23 and 27 above, further in view of Roy-Chowdhury (Roy-Chowdhury, Amber; Bellas, Nikolas; Banerjee, Prithviraj; "Algorithm-Based Error-Detection Schemes for Iterative Solution of Partial Differential Equations", 1996, IEEE Transactions on Computers, Vol. 45, No. 4).

a. Press as modified by Rumpf teaches a hardware graphics pipeline implemented method for generating a solution to a partial differential equation in a hardware graphics pipeline.

b. Regarding claim 19:

- c. Press does not specifically teach:
 - i. The determining whether the solution has converged includes calculating errors;
- d. Roy-Chowdhury appears to teach:
 - i. The determining whether the solution has converged includes calculating errors (page 400, left-side column, top-half);
- e. The motivation to use the art of Roy-Chowdhury with the art of Press as modified by Rumpf would have been the benefit recited in Roy-Chowdhury that the presented algorithm-based fault tolerance is an inexpensive method of achieving fault tolerance without requiring any hardware modifications, especially for iterative solution of linear systems arising from discretization of partial differential equations (page 394, Abstract).
- f. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Roy-Chowdhury with the art of Press as modified by Rumpf to produce the claimed invention.

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- g. Regarding claim 20:
- h. Press does not specifically teach:
 - i. The determining whether the solution has converged further includes summing the errors;
- i. Roy-Chowdhury appears to teach:
 - i. The determining whether the solution has converged further includes summing the errors (page 400, left-side column, top-half);

=====

- j. Regarding claim 21:
- k. Press does not specifically teach:
 - i. Concluding that the solution has converged if the error is less than a predetermined amount;

I. Roy-Chowdhury appears to teach:

- i. Concluding that the solution has converged if the error is less than a predetermined amount (page 400, left-side column, top-half);

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15. Claims 3 - 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Press as modified by Rumpf as applied to claims 1 - 2, 12 - 18, 22 - 23 and 27 above, further in view of Weiskopf (Weiskopf, Daniel; Hopf, Matthias; Ertl, Thomas; "Hardware-Accelerated Visualization of Time-Varying 2D and 3D Vector Fields by Texture Advection via Programmable Per-Pixel Operations", 2001, Proceedings of the Vision Modeling and Visualization Conference 2001).

- a. Press as modified by Rumpf teaches a hardware graphics pipeline implemented method for generating a solution to a partial differential equation in a hardware graphics pipeline.
- b. Regarding claim 3:
- c. Press does not specifically teach:
 - i. the input includes textures;
- d. Weiskopf appears to teach:
 - i. the input includes textures (pages 668 - 669, section 3 Hardware-Based 2D Texture Advection; and page 668, figure 1, box "Load flow to texture Tv; it would have been obvious that the input includes textures; please note that the partial differential equation on page 667, right-side column, second paragraph, is being solved);
- e. The motivation to use the art of Weiskopf with the art of Press and Rumpf would have been the benefit recited in Weiskopf that an advantage of the invention is extremely high simulation speed (page 672, right-side column, fourth paragraph that starts with "An advantage . . .").
- f. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Weiskopf with the art of Press and Rumpf to produce the claimed invention.

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- g. Regarding claim 4:
- h. Press does not specifically teach:
 - i. the input includes geometry;
- i. Weiskopf appears to teach:
 - i. the input includes geometry (pages 668 - 669, section 3 Hardware-Based 2D Texture Advection; it would have been obvious that the input includes geometry; please note that the partial differential equation on page 667, right-side column, second paragraph, is being solved);

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- j. Regarding claim 5:
- k. Press does not specifically teach:
 - i. the geometry is selected from the group consisting of polygons, vertex data, points, and lines;
- l. Weiskopf appears to teach:
 - i. the geometry includes points (pages 668 - 669, section 3 Hardware-Based 2D Texture Advection; it would have been obvious that the input includes geometry; please note that the partial differential equation on page 667, right-side column, second paragraph, is being solved);

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- m. Regarding claim 6:
- n. Press does not specifically teach:
 - i. the input includes a local area of textures;
- o. Weiskopf appears to teach:
 - i. the input includes a local area of textures (pages 668 - 670, section 3 Hardware-Based 2D Texture Advection; it would have been obvious that the input includes a local area of textures; please note that the partial differential equation on page 667, right-side column, second paragraph, is being solved);

16. Claims 7 - 9 and 24 - 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Press as modified by Rumpf and Weiskopf as applied to claims 3 - 6 above, further in view of Ewins (Ewins, Jon P.; Waller, Marcus D.; White, Martin; Lister, Paul F.; "MIP-Map Level Selection for Texture Mapping", 1998, IEEE Transactions on Visualization and Computer Graphics, Vol. 4, No. 4).

- a. Press as modified by Rumpf and Weiskopf teaches a hardware graphics pipeline implemented method for generating a solution to a partial differential equation in a hardware graphics pipeline.
- b. Regarding claim 7:
- c. Press does not specifically teach:
 - i. the local area of textures is generated by sampling a texture map;
- d. Ewins appears to teach:
 - i. sampling a texture map (pages 318 - 319, section 1.1 Texture Filtering);
- e. The motivation to use the art of Ewins with the art of Press as modified by Rumpf and Weiskopf would have been the benefit recited in Ewins that texture mapping allows a high degree of visual complexity without the expense of overly complex geometric modeling (page 317, section 1 Introduction, and Abstract).
- f. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Ewins with the art of Press as modified by Rumpf and Weiskopf to produce the claimed invention.

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- g. Regarding claim 8:
- h. Press does not specifically teach:
 - i. the local area of textures is filtered;
- i. Ewins appears to teach:
 - i. the local area of textures is filtered (pages 318 - 319, section 1.1 Texture Filtering);

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- j. Regarding claim 9:
 - k. Press does not specifically teach:
 - i. the local area of textures is filtered utilizing a plurality of filters;
 - l. Ewins appears to teach:
 - i. the local area of textures is filtered utilizing a plurality of filters (pages 318 - 319, section 1.1 Texture Filtering);
- =====

- m. Regarding claim 24:
 - n. Press does not specifically teach:
 - i. the filtering is carried out using a programmable filter;
 - o. Ewins appears to teach:
 - i. the filtering is carried out using a programmable filter (pages 318 - 319, section 1.1 Texture Filtering);
- =====

- p. Regarding claim 25:
 - q. Press does not specifically teach:
 - i. the filtering is carried out using a non-programmable filter;
 - r. Ewins appears to teach:
 - i. the filtering is carried out using a non-programmable filter (pages 318 - 319, section 1.1 Texture Filtering);
- =====

17. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Press (Press, William H.; Flannery, Brian P.; Teukolsky, Saul A.; Vetterling, William T.; "Numerical Recipes in Fortran 77", 2001, Second edition, Cambridge University Press) in view of Rumpf (Martin Rumpf et al.; "Using Graphics Cards for Quantized FEM Computations", September 3 - 5 2001, Proceedings of the IASTED International Conference on Visualization, Imaging and Image Processing).

- a. Regarding claim 10:

b. Press appears to teach:

- i. Receiving input (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that input is required to solve a partial differential equation, especially given the statement that an initial distribution relaxes to an equilibrium distribution on page 855);
- ii. Processing the input to generate the solution to the partial differential equation (pages 854-856, section 19.5 Relaxation Methods for Boundary Value Problems);

c. Press does not specifically teach:

- i. Receiving input in the hardware graphics pipeline;
- ii. Processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline;
- iii. Wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline;
- iv. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline;
- v. Wherein the input includes a local area of textures;
- vi. Wherein the local area of textures is filtered utilizing a filter including a plurality of elements.

d. Rumpf appears to teach:

- i. Receiving input in the hardware graphics pipeline (third page, figure 1);
- ii. Processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline (third page, section 3.1 Vector Representation, first paragraph; and seventh page, section 6. Linear Heat Equation, first paragraph);
- iii. Wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline (seventh page, section 6. Linear Heat Equation, first paragraph);

- iv. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline (ninth page, figure 3, displays surfaces and objects rendered by utilizing the solution to a partial differential equation utilizing a hardware graphics pipeline).
 - v. Wherein the input includes a local area of textures (third page, figure 1; please note the textures input);
 - vi. Wherein the local area of textures is filtered utilizing a filter including a plurality of elements (seventh page, right-side column, second and third paragraphs; please note that a convolution operation is a filter operation).
- e. The motivation to use the art of Rumpf with the art of Press would have been the benefits recited in Rumpf that the presented strategy opens a wide area of numerical applications for hardware acceleration (first page, Abstract, first paragraph), and turns a graphics card into an ultrafast vector coprocessor (first page, Abstract, first paragraph), which would have been recognized by the ordinary artisan as benefits that allow faster processing.
- f. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Rumpf with the art of Press to produce the claimed invention.

18. Claims 26, 28 and 30 - 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Press (Press, William H.; Flannery, Brian P.; Teukolsky, Saul A.; Vetterling, William T.; "Numerical Recipes in C", 1988, Cambridge University Press) in view of Rumpf (Martin Rumpf et al.; "Using Graphics Cards for Quantized FEM Computations", September 3 - 5 2001, Proceedings of the IASTED International Conference on Visualization, Imaging and Image Processing).

- a. Regarding claim 26:
- b. Press appears to teach:
 - i. Processing input (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that input is required to solve a partial

differential equation, especially given the statement that an initial distribution relaxes to an equilibrium distribution on page 673);

ii. Processing input to generate a solution to partial differential equations (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);

c. Press does not specifically teach:

i. A hardware graphics pipeline for processing input to generate a solution to partial differential equations wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline;

ii. Wherein the graphics processing operation performed by the hardware graphics pipeline is enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline.

d. Rumpf appears to teach:

i. A hardware graphics pipeline for processing input to generate a solution to a partial differential equation wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline (third page, section 3.1 Vector Representation, first paragraph; and seventh page, section 6. Linear Heat Equation, first paragraph);

ii. Wherein the graphics processing operation performed by the hardware graphics pipeline is enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline (ninth page, figure 3, displays surfaces and objects rendered by utilizing the solution to a partial differential equation utilizing a hardware graphics pipeline).

e. The motivation to use the art of Rumpf with the art of Press would have been the benefits recited in Rumpf that the presented strategy opens a wide area of numerical applications for hardware acceleration (first page, Abstract, first paragraph), and turns a graphics card into an

ultrafast vector coprocessor (first page, Abstract, first paragraph), which would have been recognized by the ordinary artisan as benefits that allow faster processing.

f. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Rumpf with the art of Press to produce the claimed invention.

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g. Regarding claim 28:

h. Press appears to teach:

i. Receiving boundary conditions (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that boundary conditions are required to solve a partial differential equation, especially since the title of the section recites Boundary Value problems);

ii. Computing the solution to generate the solution to the partial differential equations involving the boundary conditions (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);

iii. Determining whether the solution has converged (page 674, first paragraph, subsection that starts with "Thus the algorithm . . .", sentence, "This procedure is then iterated until convergence.");

iv. If the solution has not converged, repeating the computing and determining (page 674, first paragraph, subsection that starts with "Thus the algorithm . . .", sentence, "This procedure is then iterated until convergence.");

v. wherein the solution to the partial differential equation is generated (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);

i. Press does not specifically teach:

i. Computing the solution to the partial differential equations involving the boundary conditions at least some of the computing done in the hardware graphics pipeline;

ii. wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline;

iii. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline.

j. Rumpf appears to teach:

- i. Receiving input in the hardware graphics pipeline (third page, figure 1);
- ii. Computing the solution to the partial differential equations at least some of the computing done in the hardware graphics pipeline wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline (third page, section 3.1 Vector Representation, first paragraph; and seventh page, section 6. Linear Heat Equation, first paragraph);
- iii. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline (ninth page, figure 3, displays surfaces and objects rendered by utilizing the solution to a partial differential equation utilizing a hardware graphics pipeline).

k. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Rumpf with the art of Press to produce the claimed invention.

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l. Regarding claim 30:

m. Press appears to teach:

- i. Receiving a first input (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that input is required to solve a partial differential equation, especially given the statement that an initial distribution relaxes to an equilibrium distribution on page 673);
- ii. Processing the first input to generate a solution to a partial differential equation (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);

- iii. wherein the solution to the partial differential equation is generated (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);
- n. Press does not specifically teach:
 - i. Receiving a first input into a hardware graphics pipeline;
 - ii. Processing the first input to generate a solution to a partial differential equation utilizing the hardware graphics pipeline;
 - iii. Receiving a second input into the hardware graphics pipeline;
 - iv. Rendering the 3D graphics image utilizing the hardware graphics pipeline, wherein the rendering utilizes the second input and the result of the processing of the first input;
 - v. wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline;
 - vi. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline.
- o. Rumpf appears to teach:
 - i. Receiving a first input into a hardware graphics pipeline (third page, figure 1);
 - ii. Processing the first input to generate a solution to a partial differential equation utilizing the hardware graphics pipeline (eighth page, left-side column, second paragraph; please note that an initial noisy image is input);
 - iii. Receiving a second input into the hardware graphics pipeline (eighth page, left-side column, second paragraph; please note that a contrast enhancing function is input);
 - iv. Rendering the 3D graphics image utilizing the hardware graphics pipeline, wherein the rendering utilizes the second input and the result of the processing of the first input (ninth page, figure 3);
 - v. wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline (seventh, eighth and ninth pages, section 7 Anisotropic Diffusion in Image Processing);

vi. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline (ninth page, figure 3, displays surfaces and objects rendered by utilizing the solution to a partial differential equation utilizing a hardware graphics pipeline).

p. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Rumpf with the art of Press to produce the claimed invention.

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q. Regarding claim 31:

r. Press appears to teach:

i. The first input comprises boundary conditions (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that boundary conditions are required to solve a partial differential equation, especially since the title of the section recites Boundary Value problems);

ii. determining whether the solution has converged (page 674, first paragraph, subsection that starts with "Thus the algorithm . . .", sentence, "This procedure is then iterated until convergence.");

iii. If the solution has not converged, repeating the computing and determining (page 674, first paragraph, subsection that starts with "Thus the algorithm . . .", sentence, "This procedure is then iterated until convergence.");

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Art Unit: 2123

19. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Press (Press, William H.; Flannery, Brian P.; Teukolsky, Saul A.; Vetterling, William T.; "Numerical Recipes in C", 1988, Cambridge University Press), further in view of Roy-Chowdhury (Roy-Chowdhury, Amber; Bellas, Nikolas; Banerjee, Prithviraj; "Algorithm-Based Error-Detection Schemes for Iterative Solution of Partial Differential Equations", 1996, IEEE Transactions on Computers, Vol. 45, No. 4) further in view of Rumpf (Martin Rumpf et al.; "Using Graphics Cards for Quantized FEM Computations", September 3 - 5 2001, Proceedings of the IASTED International Conference on Visualization, Imaging and Image Processing).

a. Regarding claim 29:

b. Press appears to teach:

- i. Receiving boundary conditions (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems; it would have been obvious that boundary conditions are required to solve a partial differential equation, especially since the title of the section recites Boundary Value problems);
- ii. computing the solution to the partial differential equation utilizing a relaxation operation involving the boundary conditions (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);
- iii. determining whether the solution has converged (page 674, first paragraph, subsection that starts with "Thus the algorithm . . .", sentence, "This procedure is then iterated until convergence.");
- iv. If the solution has not converged, repeating the computing and determining (page 674, first paragraph, subsection that starts with "Thus the algorithm . . .", sentence, "This procedure is then iterated until convergence.");
- v. if the solution has converged, incrementing a time value (page 658, second paragraph, sentence that starts, "To solve equation (17.2.8) . . ."); and
- vi. repeating the foregoing operations using the incremented time value (page 658, second paragraph, sentence that starts, "To solve equation (17.2.8) . . .").
- vii. wherein the solution to the partial differential equation is generated conditions (pages 673-676, section 17.5 Relaxation Methods for Boundary Value Problems);

c. Press does not specifically teach:

- i. Receiving boundary conditions in the form of at least one of geometry and textures;

- ii. computing the solution to the partial differential equation utilizing a relaxation operation involving the boundary conditions at least some of the computing done in the hardware graphics pipeline;
 - iii. determining whether the solution has converged by:
 - (1) calculating the errors,
 - (2) summing the errors, and
 - iv. concluding that the solution has converged if the sum of errors is less than a predetermined amount;
 - v. wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline;
 - vi. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline.
- d. Roy-Chowdhury appears to teach:
- i. determining whether the solution has converged by:
 - (1) calculating the errors (page 400, left-side column, top-half),
 - (2) summing the errors (page 400, left-side column, top-half), and
 - ii. concluding that the solution has converged if the sum of errors is less than a predetermined amount (page 400, left-side column, top-half);
- e. Rumpf appears to teach:
- i. Receiving boundary conditions in the form of at least one of geometry and textures (third page, figure 1);
 - ii. wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline (seventh page, section 6. Linear Heat Equation, first paragraph);
 - iii. Wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the

hardware graphics pipeline (ninth page, figure 3, displays surfaces and objects rendered by utilizing the solution to a partial differential equation utilizing a hardware graphics pipeline).

- f. The motivation to use the art of Roy-Chowdhury with the art of Press would have been the benefit recited in Roy-Chowdhury that the presented algorithm-based fault tolerance is an inexpensive method of achieving fault tolerance without requiring any hardware modifications, especially for iterative solution of linear systems arising from discretization of partial differential equations (page 394, Abstract).
- g. The motivation to use the art of Rumpf with the art of Press would have been the benefits recited in Rumpf that the presented strategy opens a wide area of numerical applications for hardware acceleration (first page, Abstract, first paragraph), and turns a graphics card into an ultrafast vector coprocessor (first page, Abstract, first paragraph), which would have been recognized by the ordinary artisan as benefits that allow faster processing.
- h. Therefore, as discussed above, it would have been obvious to the ordinary artisan at the time of invention to use the art of Roy-Chowdhury and the art of Rumpf with the art of Press to produce the claimed invention.

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20. Examiner's Note: Examiner has cited particular columns and line numbers in the references applied to the claims above for the convenience of the applicant. Although the specified citations are representative of the teachings of the art and are applied to specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested from the Applicant in preparing responses, to fully consider the references in their entirety as potentially teaching all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner. The entire body of all references are considered as being recited to teach the claimed invention.

Allowable Subject Matter

21. Claim 11 is allowable over the prior art of record.

22. As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

23. A statement of reasons for the indication of allowable subject matter for claim 11 was included in the previous Office Action.

Conclusion

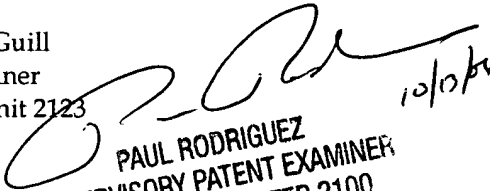
24. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Russ Guill whose telephone number is 571-272-7955. The examiner can normally be reached on Monday - Friday 10:00 AM - 6:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Rodriguez can be reached on 571-272-3753. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Any inquiry of a general nature or relating to the status of this application should be directed to the TC2100 Group Receptionist: 571-272-2100.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

RG

Russ Guill
Examiner
Art Unit 2123


PAUL RODRIGUEZ
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2100
10/10/02